I have given it in detail and I have discussed it.

Then I come to the margin of profit. My friend, Mr. Jagesh Desai claims to be an economist. (*Interruptions*). Once upon a time he was a Minister. He says that profit is not included. Now Sir, the econom theory says that profit is not a part of the cost. Cost is not decided by profit. On the contrary, profit is decided by cost. That is the economic theory and the entrepreneur gets profit because the entrepreneur is tak ing a risk and that risk taking quality of the entrepreneur is rewarded ir terms of profit.

श्री राम अवधेश सिंह : क्या किसान खतरा नहीं उठाता है ? क्या आंध्रप्रानरी खतरा उठाता है, वह वाह रे वाह।

SHRI YOGENDRA MAKWANA: That is a notional comparison. It is a national comparison. Profit and cost are two different elements and when I say that prices are fixed based on the cost of production, the cost of production cannot include profit. But we give a little margin to the farmers after calculating the cost and that margin if you want to call it profit. but it is an incentive, it is not a profit. It is an incentive given to the farmer in order to invest more in his agricultural profession, i.e. by way of inputs, pesticides, fertiliser, better seeds and all that. That is what we want. And therefore we give a little bit margin and not as Mr. Jagesh Desai said.

Then I come to prices and drought conditions. Drought is a natural calamity, and a natural calamity cannot be linked with normal economic activity. For that, whenever there is a natural calamity, the Government of India is coming to the help of the State Government and to the help of the farmers also. We provide input sibsidies and a number of things to the farmers through State Governments in case there is failure of crop due to failure of monsoon, and if there is a drought, we help the State Government, and I have given figures in the House several times as to how much we have given to the State Governments. Therefore, it cannot be compared with the price fixation.

श्री राम अवधेश सिंह : फसल बीमा का क्या हुआ, मंत्री जी बतायें।

श्री योगेन्द्र मकवाना : आप थे ही नहीं जब मैंने बताया।

उपसभाध्यक्ष (श्री हंच० हनुमनतप्पा) : राम अवधेश जी आप नहीं थे तब जवाब दिया था।

III. Failure Analysis of the First Development Flight to augmented Stellite Launch Vehicle (ASLV-DI)

THE MINISTER OF STATE IN THE MINISTRY OF SCIENCE AND TECHNOLOGY AND THE MINISTER OF STATE IN THE DEPARTMENTS OF OCEAN DEVELOPMENT, ATOMIC ENERGY, ELECTRONICS AND SPACE (SHRI K. R. NARAYANAN): Sir, the Honourable Members may kindly recall that I had made a statement in the House on 16th April, 1987 regarding the launch of the first developmental flight of ASLV D1 which took place from Sriharikota on March 24, 1987. As the mission was not successful, I had indicated that further analysis of the data would continue to understand the reasons of the failure in order to incorporate modifications as necessary for future vehicles.

While the expert teams were conductingt he post flight analysis of failure, a Failure Analvsis Committee (FAC), was constituted to find the cause of the failure with Sri R. Aravamudan, Director, ISRO Reliabilitv (ISREL) as its Chairman. The FAC has submitted its final report and recommendations to the Chairman, ISRO/Secretary, Department of Space

based on detailed analysis of the voluminous data obtained in the flight. In arriving at its conclusions the FAC had co-opted over a hundred specialists from various disciplines as well as a number of eternal experts including Dr. APJ Abdul Kalam, Director, DRDL, Hyderabad (Former Project Director, SLV-3, E1 and E2), Sri V. P. Sandlas, Directors, DEAL, Dehradun (Former Project Director, SLV-3, D1 and D2).

The FAC constituted seventeen subcommittees to carry out in-depth studies and conduct investigative/confirmative tests where necessary in specific areas such as the first stage (ASI) ignition system consisting of igniter, safe/arm, the electrical circuit, vibration levels etc.

The data from the following sources were analysed by the FAC:

—Vehicle telemetry data

—Spacecraft telemetry data

—Ground-station data on tracking

—Vehicle check out data

—the debris from the flight

—Visual observations

—Video records

—Photographic records

—Kinetheodolite pictures

—Documents|log books pertaining to specification, design, qualification, process, acceptance, integration and pre-launch operations.

In addition, data were also specifically generated to assist the failure analysis through failure mode simulation and certain investigative tests.

The failure analysis confirms that after a perfect lift-off the vehicle had functioned nominally upto 48.74 sec. and that thereafter the first stage did not ignite even though the ignition command was sent by the On-board Computer, thereby causing loss control of the vehicle. The strap-on motors separated even under this adverse environment at the intended time of 52.2 sec. However, the large aero-dynamic loads experienced by the vehicle due to loss of control resulting from the non-ignition of 1s stage, caused the severance of the vehicle at the interface between the second and the third stages at 52.4 sec. The third stage has ignited at the intended time of 156.8 sec. and performed nominally till the splash down at 164 sec. after launch.

Having established the non-ignition of the first stage as the cause of failure, the failure analysis efforts were specifically focused on the regime of flight upto 50 sec., even though detailed analysis of the data all the way till ASLV splash down at 164 sec. was conducted. An exhaustive list of thirty seven possible failure modes was identified in the areas of igniter, safe/arm unit, ignition circuit and the check out system. They include problems relating to vacuum ignition, structural resonance, de-mating of connectors in flight, effect of acceleration on safe/arm etc.

The data from the Shock, Acoustic And Vibration Experiment (SAVE) payload in the SROSS-I satellite indicated that the acoustic levels monitored at the satellite are within the design limits and as per predictions based on the extensive tests carried out earlier. Data obtained from the vibration sensors mounted along various points in the vehicle indicated that the vibration levels experienced by the vehicle are within the qualification levels. Data from strain, temperature and acceleration sensors also indicate normal performance till the malfunction of the first stage. After detailed examination of all these failure modes, seen in the context of the available data on the vehicle performance, the FAC has ruled out the possibility of occurrence of any of these failure modes.

After an exhaustive and in-depth analysis of all flight data and extensive stimulation studies, the FAC has concluded that the failure of the ASLV mission was primarily due to non-ignition of the AS1 motor, and that the non-ignition of the motor could only be explained by an extremely small but finite probability of:

(a) Inadvertent short circuit in both the ignition circuits;

(b) Inadvertent electrical open circuit in both the ignition circuits;

(c) Random malfunction of safe/arm device.

All these three possible failure mechanisms being of random nature, pinpointing a single cause of failure amongst the three, through post-facto reconstruction of the events has not been possible. Such a situation is not uncommon to aero-space failure mechanisms, particularly when the cause of failure is attributable to random phenomena having a small probability of occurrence and hence not repeatable.

In order to ensure realisation of successful launch of future ASLV's, the FAC has made a comprehensive set of recommendations to further improve reliability of performance and incorporate adequate redundancy measures taking specifically into account all the three possible failure causes. All the steps recommended by the FAC are being incorporated for the second development flight of ASLV.

The assessment of the expert teams during the failure analysis deliberations is that in spite of the failure of the mission, the new technology of strap-on development has been substantially proven in the flight and no modifications have been suggested to this system. The Inertial Guidance System has also performed nominally. However, the closed loop guidance system did not get an opportunity to perform fully in view of the premature termination of the flight, even though the limited data gathered by this system shows nominal performance.

The preparations for the next ASLV flight incorporating the necessary changes are progressing satisfactorily, to realise a successful launching of ASLV in early 1988. The next ASLV will launch the second Streched Rohini Series Satellite (SROSS-II) with the joint ISRA-DFVLR stereo imaging telescope (MEOSS) as the primary payload.

PROF. C. LAKSHMANNA (Andhra Pradesh): Mr. Vice-Chairman, Sir, the ASLV had raised high hopes in the nation; unfortunately, it did not take off. Now, I have only one or two clarifications to seek from the hon. Minister. The Minister says here:

> "Such a situation is not uncommon to aero-space failure mechanisms, particularly when the cause of failure is attributable to random phenomena having a small probability of occurrence and hence not repeatable."

This means, the failure could be attributable to something which was random, which is not repeatable and, therefore, the failure is only a matter of snag. But then he goes on to say:

> "In order to ensure realisation of successful launch of future ASLV's, the FAC has made a comprehensive set of recommendations to further improve reliability of performance and incoroprate adequate redundancy measures taking specifically into account all the three possible failure causes."

I would request the hon. Minister to kindly explain what is the reason for not pinpointing as to which of the three causes was responsible for this. If it is purely an accidental, random phenomenon, in what way the measures that have been suggested with regard to the three will be helpful? In spite of the fact that these three

[Prof. C. Lakshmanna]

mechanisms could be corrected, there could still be a random failure, maybe, not repeatable but a possibility could be there. This is one question.

Secondly, what were the uses to which this ASLV was supposed to be put? What have been the difficulties arising out of the failure of this ASLV and in what way the functions to which this ASLV was supposed to be put, have been performed? When the new satellite is launched, what will happen to the arrangements followed to meet those fundamental requisites which would have been contingently made arranged for successful launching of this. And finally, what is the cost involved in it? Was there any insurance for it? What is the cost that the country has to bear? I would like to ask clarifications to these points.

DR. R. K. PODDAR (West Bengal): Mr. Vice-Chairman, Sir, the Minister has said that there was some random phenomenon responsible for its failure. The phenomenon could not be predicted before and, therefore, adequate redundancy measures were necessary. I would like to know why these measures were not taken before. When the kind of failure in mechanisms is easily anticipated now, why it could not be done earlier. Is it that the scientists were hastened to launch this vehicle before it was ready? Also this report does not say anything about the human failure. Sometimes small errors lead to tragic events, like the Chernobyl or the Long Island, where the failure has been traced to the human error. Whether any human error was involved at any stage or during the assembly stage, I want to know that. During the question hour this morning itself you were faced with the question that sometimes bureaucratic culture is being involved into our scientific world. A hierarchy system is being introduced. The technicians and those who are lower down the scale, feel alienated from the top brass of the scientists' hierarchy. You should enthuse them to take part in this programme. If they are given participation, perhaps they would be more careful and there would be less number of tragic events.

PROF. (MRS.) ASIMA CHATTERJEE (Nominated): Mr. Vice-Chairman, Sir, after exhaustive indepth analysis, it has been possible for them to find out the factors which are responsible for the failure. The factors suggested are: (a) inadvertent short circuit in both the ignition circuits; (b) inadvertent electrical open circuit in both the ignition circuits; and (c) random malfunction of safe/arm device. I would like to know which particular factor has been identified, has been pinpointed because in future when there will be launching of the satellite the scientists must be more particular about those points so that these sort of miscalculations are not repeated. Secondly, I would like to know whether any new technology has been developed meanwhile for the correction of this failure. These are the two questions I would like to ask of the hon. Minister.

SHRI K. R. NARAYANAN: Sir, with regard to the three possible reasons given by the Failure Analysis Report, I would like to say that it has not been possible to identify whether it was due to one or the other reason exactly that it failed. They narrowed down the causes to these three. They examined all other factors involved, including the human factor, and came to the conclusion that nothing could have failed except these three possibilities mentioned here.

As to why it has been said that it is not uncommon for such failure mechanisms is because it has been proved by the previous history of launches. You will recall that when INSAT 1A was launched, the solar sail did not function. Elaborate checking and investigations were made and they could not precisely pinpoint what exactly failured there. But we did succeed in sending out INSAT 1B

[Shri K.R. Narayanan]

which is still going round. These random failures do take place because short circuit in the ignition is something, for which of course we took every care that there should not be any defective wiring or short circuit possible, but still in such experiments, such ventures, these kinds of things do take place. For example the American Delta launch had failed. It was not an experimental launch like ours; it was a proven, commercial launch; and they could not so far find out the precise reason why that failed, because something went up into the space and we are trying to analyse it from the earth from what happened to it. But our enquiry committee—the Failure Analysis Committee—eliminated all other reasons except these three.

What we can do in the future is to make even more sure than we did in the beginning that the circuit system is checked again and again. It is not that it was not checked. It was checked. In fact I was there at Sriharikota. Even before it went up, the computer showed everything in perfect order. Every part was checked again on the computer and everything was declared to be in perfect order before the final command was given for take-off. But then if a short circuit took place or if the safe arm did not function, there was something which was completely unanticipated and we could not have corrected it earlier. That is why it has been mentioned as a random failure. I think we have to take into account that such disappointments and failures are probably unavoidable in such ventures. Just as the first SLV flight did not go up, it was a failure, the second one did go up and the third one did go up. So these are the risks involved, random risks involved in such highly sophisticated scientific experiments. Therefore these three areas mentioned would be particularly examined and care would be taken that there would not be any possibility of any occurrence of failure there. That is all that is humanly, scientifically possible.

Now with regard to cost analysis, well, the cost of the launch vehicle was Rs. 6 crore and of the satellite-I Rs. 4 crore. This is the actual loss involved. There was no insurance. As you know, it was a Government venture, we do not insure such things. It is a loss in that particular sense but it is also an experience we have gained so that we could take greater precautions. There is no new technology that is being developed for this purpose, because it was not technology that failed. As you know, for the ASLV the first stage motor was the same motor which was used in SLV-3 successfully. Therefore, no technological improvement is required in this though, of course, we always try to reach out to new technologies.

4.00 P.M.

About involvement of human failure, the Committee did not find that there was any human failure involved in this particular failure of the launch.

One more point about bureaucratic culture with regard to scientists. I just want to say that our space effort has been one of the most successful, harmonious, efforts in any field which the Indian nation has undertaken. Thousands of scientists and technicians have worked together to produce these achievements. I have not come across any disharmony or discontent in the system, and those who are operating it are scientists and technicians and not bureaucrats. I want particularly to say that the Prime Minister himself, immediately after the failure of the launch, paid a tribute to the harmonious working of the entire corps of scientists and technicians as well as administrators involved in this experiment.

As I said, we are looking forward to the launch early next year and, I hope, with the good wishes of the House and the Indian people, this would be a success. Thank you.